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Title: Combustion device

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Printed publications to be consulted for the evaluation of the patentability:

CH 570 191

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1. The following is a list of the names of the persons who have been appointed to the various committees of the Board of Directors of the American Telephone and Telegraph Company, for the year ending December 31, 1910:

Claims

1. Combustion device with a combustion chamber, to which the material to be oxidised is supplied via at least one inlet opening and from which the oxidised exit gases flow to an outlet opening, characterised in that radiators (3) are installed which generate in the combustion chamber (2) an electric field within which the material to be oxidised oxidises in combination with a low-oxygen gas mixture supplied via an inlet opening (15).
2. Combustion device according to claim 1, characterised in that a plurality of rod-shaped radiators (3) impinge upon the combustion chamber (2) in a uniformly distributed manner.
3. Combustion device according to claim 1, characterised in that the radiators (3) are at least partly surrounded by a radiation-reflecting wall (16).
4. Combustion device according to claim 3, characterised in that the radiation-reflecting wall (16) forms the tubular combustion chamber wall and the radiators (3) project coaxially into the combustion chamber (2) from a face wall (4).
5. Combustion device according to claim 4, characterised in that the radiators (3) are combined into at least one plug-in unit (7) which is fixable in a face wall (4) in a detachable manner.
6. Combustion device according to claim 5, characterised in that the radiators (3) are secured in the plug-in unit (7) by their unheated ends and project into the combustion chamber (2) with their other ends.
7. Combustion device according to claim 1, characterised in that the radiators (3) are shielded from the combustion chamber (2) by a radio-transparent cover.

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6. The following information is required for the purpose of this application:

8. Combustion device according to claim 7, characterised in that the cover consists of quartz glass.
9. Combustion device according to claim 1, characterised in that the radiator (3) consists of a quartz glass tube (5) in which an electric heating wire (6) is accommodated.
10. Combustion device according to claim 4, characterised in that the combustion chamber wall starts at axial distance (8) from the casing face wall (4) and is prolonged beyond the free facing end (17) of the radiators (3) to form a residual burning zone (18).
11. Combustion device according to claim 4, characterised in that the combustion chamber wall is jacketed and the escaping oxidised gas passes through the jacketing (9) to the outlet opening (14).
12. Combustion device according to claim 11, characterised in that the jacketing (9) is surrounded by a casing (1) and the low-oxygen gas mixture entering via the inlet opening (15) is brought to the radiators (3) or to the combustion chamber (2) for a pre-heating between the jacketing (9) and the casing (1).
13. Combustion device according to claims 1 and 12, characterised in that the radiators (3), the combustion chamber (2), the jacketing (9) and the casing (1) are arranged concentrically to one another.
14. Combustion device according to claim 1, characterised in that the casing (1) is subdivided into the combustion chamber (2) and three surrounding chambers, namely a stabilisation chamber (11), a pre-heating chamber (12) and a feed chamber (10).

The first step in the process of the invention is to determine the scope of the invention. This is done by identifying the prior art and the novel features of the invention. The next step is to define the invention in terms of its components and their interrelationships. This is done by drafting a set of claims that define the invention in a way that is both broad enough to cover the invention and narrow enough to distinguish it from the prior art.

The third step in the process is to conduct a search of the prior art. This is done by searching the relevant databases and literature for any prior art that may be relevant to the invention. The search results are then analyzed to determine the scope of the prior art and the novelty of the invention.

The fourth step in the process is to draft a set of claims that define the invention. This is done by identifying the novel features of the invention and drafting claims that cover these features. The claims are then reviewed and revised as necessary to ensure that they are both broad enough to cover the invention and narrow enough to distinguish it from the prior art.

The fifth step in the process is to file the patent application. This is done by submitting the set of claims and the other required information to the appropriate patent office. The patent office will then review the application and determine whether the invention is eligible for a patent.

THE INVENTION IS A METHOD FOR DETERMINING THE SCOPE OF A PATENT. THE METHOD COMPREHENDS THE FOLLOWING STEPS: (1) IDENTIFYING THE PRIOR ART; (2) DETERMINING THE NOVEL FEATURES OF THE INVENTION; (3) DRAFTING A SET OF CLAIMS THAT DEFINE THE INVENTION; (4) CONDUCTING A SEARCH OF THE PRIOR ART; (5) ANALYZING THE SEARCH RESULTS TO DETERMINE THE SCOPE OF THE PRIOR ART AND THE NOVELTY OF THE INVENTION; (6) DRAFTING A SET OF CLAIMS THAT DEFINE THE INVENTION; (7) REVIEWING AND REVISING THE CLAIMS AS NECESSARY TO ENSURE THAT THEY ARE BOTH BROAD ENOUGH TO COVER THE INVENTION AND NARROW ENOUGH TO DISTINGUISH IT FROM THE PRIOR ART; (8) FILING THE PATENT APPLICATION; (9) SUBMITTING THE SET OF CLAIMS AND THE OTHER REQUIRED INFORMATION TO THE APPROPRIATE PATENT OFFICE; (10) REVIEWING THE APPLICATION AND DETERMINING WHETHER THE INVENTION IS ELIGIBLE FOR A PATENT.

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15. Combustion device according to claim 14, characterised in that the gases in the feed chamber (10) and in the stabilisation chamber (11) flow in the opposite direction to the gases in the combustion chamber (2) and in the pre-heating chamber (12).
16. Combustion device according to claim 14, characterised in that the chamber walls are formed at least in part of plate/shell-and-tube heat exchangers.
17. Combustion device according to claim 2, characterised in that the gases in the combustion chamber (2) flow parallel in co-current with the rod-shaped radiators (3).
18. Combustion device according to claim 1, characterised in that the inlet opening (15) is provided on the periphery in the vicinity of the one face wall (13) of the cylindrical casing (1), and the outlet opening (14) in said face wall (13) lying opposite the face wall (4) comprising the radiators (3).
19. Combustion device according to claim 1, characterised in that between the housing (1) and the combustion chamber (2) are provided feed elements (19) for combustible materials, which are added to the low-oxygen gas mixture prior to further oxidation.
20. Combustion device according to claim 19, characterised in that the feed elements (19) are passed through the face wall (4) of the casing (1) comprising the radiators (3).
21. Combustion device according to claim 1, characterised in that an additional burner is installed for heating during start-up.

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Combustion device

The invention relates to a combustion device with a combustion chamber, to which the material to be oxidised is supplied via at least one inlet opening and from which the oxidised exit gases flow to an outlet opening.

With the known burners a fuel-combustion air mixture is generated and then ignited. In order to maintain a stable burning process, a constant flame temperature of about 1200 to 1400 °C is required, while a minimum oxygen content of approx. 14 to 16% must be observed for a residue-free combustion. The combustion air must be additionally blended and heated, and to improve the burning result a turbulence must be generated in the combustion chamber. Because of the high temperatures a high nitrogen oxide formation cannot be avoided, the exit gases are aggressive, the fuel consumption is high, the economic efficiency low.

The invention is based on the object of creating a combustion device which is suited to burning combustible materials economically and in an environmentally friendly manner using low-oxygen gas mixtures.

To achieve said object, the invention provides that radiators are installed, which generate in the combustion chamber an electric field within which the material to be oxidised oxidises in combination with a low-oxygen gas mixture supplied via the one inlet opening. The low-oxygen gas mixture is as a rule an exit gas from another plant whose heat content (gas temperature e.g. 200 °C) may be additionally exploited. It suffices if said gas mixture has an oxygen content which is required for the stoichiometric oxidation, i.e. only a low percentage of O₂. Because of the constantly present electric radiation field, a continuous oxidation is already ensured at a temperature of 600 to 750 °C. Due to the fact that no additional combustion air has to be added and heated and operation at a very low combustion chamber temperature is possible, a particularly high economic efficiency is obtained. In addition, not only may low-oxygen gas mixtures continue to be used, but in particular excellent burning results may also be achieved

1. *Chlorophyll a* and *Chlorophyll b* are the primary photosynthetic pigments in most plants. They absorb light energy in the blue and red regions of the visible spectrum.

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1. The first step in the process of creating a new product is to identify a market need. This is often done through market research, which can involve surveys, focus groups, and other methods of gathering information about consumer preferences and behaviors. Once a market need has been identified, the next step is to develop a concept for a product that addresses that need. This concept should be based on a clear understanding of the target market and the unique value proposition that the product will offer.

despite the relatively low combustion chamber temperature, the organically bonded carbon drops from 10 to 50 ppm, with conventional burners below the limit of detection, the CO value falls from 500 ppm to less than 5 ppm, and the nitrogen oxide values, which conventionally come to 200 to 500 ppm, reduce to less than 10 ppm.

Said combustion device enables combustible materials to be burnt together with low-oxygen gas mixtures, so that the latter may be further utilised. In particular pollutants are removed almost completely from the gas mixture supplied, the exit gases containing only minute proportions of environmentally harmful and corrosion-promoting substances such as e.g. phosgenes, carbon monoxide and similar. Substances particularly difficult to oxidise, such as chlorinated hydrocarbons, may be burnt with only a small amount of energy, likewise intrinsically explosive mixtures which are rendered inert. The combustion device may also be used preferably as an integrated unit for the generation of inert gases without additional use of energy.

In a particularly advantageous manner, a plurality of rod-shaped radiators are provided which impinge uniformly on the combustion chamber, so that a homogeneous radiation field is generated. Said radiators are suitably surrounded at least in part by a radiation-reflecting wall, so that all of the radiation energy is made available to the oxidation process. It is advantageous for assembly and repair purposes if the radiators are combined into at least one plug-in unit, which is fixable in a face wall in a detachable manner, the radiators being secured in the plug-in unit by their unheated ends, while their other ends project into the combustion chamber. The radiators may be shielded from the combustion chamber by a radio-transparent cover, so that the passing gases do not come directly into contact with the radiators. A laminar flow is desirable here, in order to maintain a low convective heat transfer. In particular the radiator may suitably consist of a quartz glass tube in which an electrical heating wire is accommodated. The radiation-reflecting wall is preferably formed by the tubular combustion chamber wall, the radiators projecting into the combustion chamber co-axially from a face wall, wherein the combustion chamber wall starts at axial distance from the face wall and is prolonged beyond the free face-wall end of the radiators in order to form a residual burning zone.

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...and other persons who are known to have been involved in the activities of the group.

As a result, the more complex the problem, the more likely the decision maker will be to use a heuristic. In fact, the more complex the problem, the more likely the decision maker will be to use a heuristic. In fact, the more complex the problem, the more likely the decision maker will be to use a heuristic.

Particularly favourable efficiencies may be achieved if the combustion chamber wall is jacketed and the escaping oxidised gas passes through the jacketing to the outlet opening. The jacketing is in turn surrounded by a casing, the low-oxygen gas mixture entering via the inlet opening being brought to the radiators or the combustion chamber for a pre-heating between the jacketing and the casing. Pre-heating temperatures of 500 to 600 °C may be achieved in this way, which are not possible with burners having a conventional combustion air composition.

The combustion device may be constructed in a space-saving and compact manner if the radiators, the combustion chamber, the jacketing and the casing are arranged concentrically to one another, and the casing is sub-divided into the combustion chamber and three surrounding chambers, namely a stabilisation chamber, a pre-heating chamber and a feed chamber. The chamber walls are preferably formed in part by plate/shell-and-tube heat exchangers. The inlet opening is to be provided on the periphery in the vicinity of the one facing end of the cylindrical casing and the outlet opening in said face, which lies opposite the face comprising the radiators. The gases in the feed chamber and in the stabilisation chamber then flow in the opposite direction to the gases in the combustion chamber and in the pre-heating chamber.

The combustible materials, e.g. fossil fuels in solid, liquid or gaseous form, or combustible pollutants (in particular hydrocarbons) may be added beforehand to the low-oxygen gas mixture supplied via the inlet opening. It is particularly suitable, however, if additional feed elements are provided for the combustible substances between the casing and the combustion chamber, the latter preferably being introduced through the face wall of the casing in the vicinity of the radiators.

In order not to have to supply the whole of the energy required for the start-up in electrical form, additional conventional gas or oil burners may be provided. The latter are switched off during the stationary operating period, in which the oxidation process takes place only by means of the electrical radiators and the injected combustible material.

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An embodiment of the invention is shown in the drawing in a diagrammatic longitudinal section and will be described in detail below.

The combustion device comprises in a casing 1 a combustion chamber 2, into which radiators 3 are introduced from a face wall 4. The radiators 3 consist of quartz glass tubes 5 in which electrical heating wires 6 are accommodated. The radiators 3 are combined into a plug-in unit 7, which is fixable in the one face wall 4 of the casing 1 and thus may be easily mounted or replaced. The combustion chamber 2 starts at an axial distance 8 from the face wall 4, it is provided with a jacketing 9, which forms towards the casing 1 a feed chamber 10, towards the combustion chamber 2 a stabilisation chamber 11, and between them a pre-heating chamber 12. The casing 1 forms substantially a cylindrical body with respect to which the jacketing 9 and the radiators 3, together with the combustion chamber 2, are arranged concentrically, so that the chambers 10 to 12 are circulatory. On the face wall 13 lying opposite the face wall 4 comprising the radiators 3 is provided an outlet opening 14 for the oxidised exit gases. On said face wall 13 is also located, on the periphery of the casing, an inlet opening 15 for the inflow of a low-oxygen gas mixture. The radiators 3 are surrounded in their rear area by a radiation-reflecting wall 16, which may represent the combustion chamber wall. The combustion chamber 2 extends beyond the free facing end 17 of the radiators 3 and in so doing forms a residual burning zone 18. In the face wall 4 are distinguishable, next to the radiators 3, feed elements 19 for combustible materials.

The low-oxygen gas mixture, e.g. an exit gas with a particular heat content and with or without an addition of combustible substances, is fed in the direction of the arrows shown, via the inlet opening 15 and the feed chamber 10, to the radiators 3 generating the electric field or to the combustion chamber 2. Unless this has already happened, combustible materials such as fossil fuels, hydrocarbons or similar are added via the feed elements 19. A virtually complete oxidation takes place, in particular in the radiator area. From the combustion chamber 2 the oxidised gases pass into the stabilisation chamber 11, so that the radiation-reflecting wall 16 remains uniformly heated to a large extent. During the return flow through the pre-heating chamber 12 heat is given off to the

1. The first part of the document is a letter from the Director of the Patent and Trademark Office to the Commissioner of the Internal Revenue Service. The letter is dated January 1, 1964, and is addressed to the Commissioner. The letter is signed by the Director and is dated January 1, 1964.

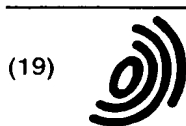
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passing low-oxygen gas mixture, so that said gas mixture is pre-heated. Consequently on the one hand the combustion chamber 2 remains hot, and on the other a high heating up of the low-oxygen gas mixture is brought about.

The combustion device may preferably be constructed in sizes of 40,000 to 60 million kJ. It is used in particular for the heating of air or water and makes it possible to further process low-oxygen gas mixtures with the generation of energy and the formation of environmentally friendly exit gases.

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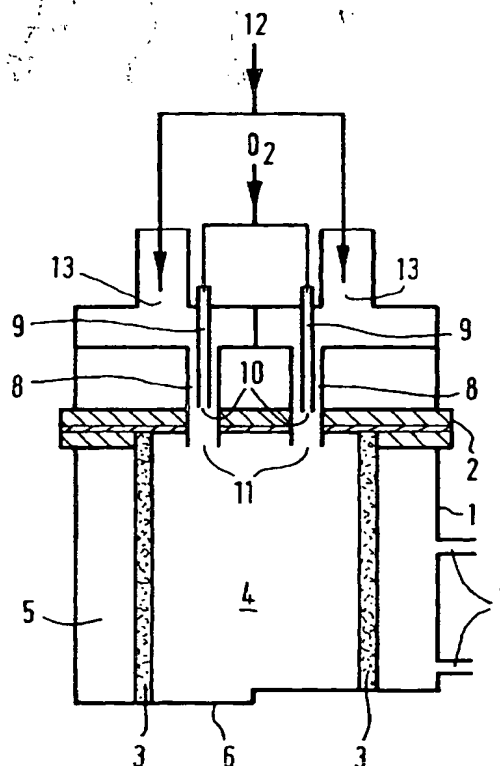
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(54) Removal of noxious substances from gas streams

(57) A process for the combustive destruction of noxious substances from a gas stream, which comprises injecting the gas stream (13) and added fuel gas (12) as a mixture into a combustion zone (4) that is surrounded by an exit surface of a foraminous gas burner (3) and simultaneously supplying a fuel gas and air/oxygen mixture (7) to the foraminous gas burner to effect combustion at the exit surface, and discharging the resulting combustion product stream from the combustion zone, wherein oxygen is added to the gas stream and the fuel gas prior to the introduction of the mixture to the combustion zone and wherein the oxygen/fuel gas mixture burns at the point of injection.



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Description

This invention relates to the removal of noxious substances from gas streams, in particular the removal of very stable fluorocarbons from gas streams emanating from i-conductor processing chambers by means of combustion.

Many substances used in semi-conductor device manufacturing, and which are extracted from a chamber in which such manufacturing takes place, are toxic and/or environmentally harmful and must therefore be scrubbed from the exhaust gas stream before its release in to the atmosphere.

A number of different types of wet or dry chemical scrubbing reactors have been proposed and numerous are commercially employed in the semi-conductor industry.

For example, in our Patent Specification No. WO 89/11905 there is disclosed a dry chemical reactor sold by our Edwards High Vacuum International Division comprising a heated packed tube of granular substances through which the exhaust stream is directed including in particular a first stage of silicon (with an optional addition of copper when the exhaust stream contains nitrogen trifluoride in particular) and a second stage of calcium oxide commonly in the form of lime. Such a reactor has met with considerable commercial success for the scrubbing of such toxic substances.

It is also known from European Patent Specification No 694 735 in the name of Alzeta Corporation, the contents of which are incorporated herein by reference, that noxious substances of the type in question can be removed from exhaust streams by combustion.

There is described in this prior Specification a process for the combustive destruction of noxious substances which comprises injecting an exhaust gas and added fuel gas in to a combustion zone that is laterally surrounded by the exit surface of a foraminous gas burner, simultaneously supplying fuel gas and air to the burner to effect combustion at the exit surface, the amount of the fuel gas supplied to the foraminous gas burner being on a BTU basis, greater than that of the added fuel gas, and the amount of the air being in excess of the stoichiometric requirement of all the combustibles entering the combustion zone, and discharging the remitting combustion product stream from the combustion zone.

A central feature of the prior combustive process is the critical need to supply the fuel gas admixed with the exhaust gas stream in to the combustion zone of the burner. Such premixing of the fuel gas and exhaust gas stream allows for a much greater and efficient scrubbing of the perfluorocarbon hexafluoroethane (C_2F_6). However, there remains certain problems associated with the scrubbing of the even more stable perfluorocarbon tetrafluoromethane (CF_4).

A great advantage of the prior combustive scrubbing process described above is that it inherently limits the maximum temperature that can be attained in the combustion chamber and thereby suppress the formation of NO_x gas by-products that may otherwise be formed.

However, the relatively low maximum temperature may become a limiting factor in the destruction of the most stable perfluorocarbon gases, in particular tetrafluoromethane (CF_4).

It has now been found that an addition of oxygen to the exhaust gas stream prior to the introduction of the gas stream in to a foraminous gas burner generally allows for a more efficient combustion of perfluorocarbon gases including tetrafluoromethane (CF_4).

In accordance with the invention, there is provided a process for the combustive destruction of noxious substances from a gas stream, which comprises injecting the gas stream and added fuel gas as a mixture in to a combustion zone that is surrounded by an exit surface of a foraminous gas burner and simultaneously supplying a fuel gas and air/oxygen mixture to the foraminous gas burner to effect combustion at the exit surface, and discharging the resulting combustion product stream from the combustion zone, wherein oxygen is added to the gas stream and the fuel gas prior to the introduction of the mixture to the combustion zone and wherein the oxygen/fuel gas mixture burns at the point of injection.

In general, the oxygen and the fuel gas should be mixed immediately prior to the introduction of the mixture in to the combustion zone.

This allows the burning of the mixture to be maximised but with a reduced potential for a "flash back". Preferably, the mixing is effected in a pipe or pipes at the end of which a nozzle or nozzles effects the introduction of the mixture towards the combustion zone and on which the burning occurs. Preferably, however, only one such nozzle is present.

Preferably the amount of oxygen added to the gas stream and fuel gas is such that the oxygen concentration of the total gas stream injected into the combustion zone is from 10 to 40% by volume, most preferably from 15 to 25% by volume.

Preferably also the fuel gas concentration of the gas stream entering the combustion zone is from 80 to 150% of the stoichiometric amount needed for combustion by the oxygen added to the gas stream.

It is important that both the fuel gas and the oxygen are introduced in to the gas stream prior to the stream being injected in to the combustion zone.

With regard to the oxygen, this is preferably introduced to the exhaust gas stream by way of an oxygen lance. Preferably a nozzle of such a lance is positioned within or in a pipe carrying the exhaust stream immediately prior to the point of injection of the gas stream in to the combustion zone.

Advantageously, the oxygen lance comprises a concentric tube within the pipe carrying the gas stream. Advanta-

geously also, the oxygen nozzle is positioned between 0.7 and 3 pipe internal diameters prior to the point of injection of the gas stream in to the combustion zone.

With regard to the fuel gas, this can be added to the gas stream at any convenient point prior to its entry in to the combustion zone. However, for reasons of potential flammability in particular, both oxygen and fuel gas should not be present for any appreciable time prior to their co-injection in to the combustion zone. If the oxygen is added to the gas stream upstream of the preferred embodiments described above and generally, it is preferably that the fuel gas is introduced in to the gas stream by means of a gas nozzle that terminates within or on the pipe carrying the exhaust stream and positioned between 0.7 and 3 pipe diameters prior to the point of injection of the exhaust stream in to the combustion zone.

The fuel gas added to the gas stream (or used in the foraminous burner operation) is preferably carbon-based, for example methane, propane or butane or at least a mixture containing predominantly methane, propane or butane. Alternatively, it may be hydrogen. The fuel gas for the gas stream and for the burner are preferably the same but may be different if appropriate.

The mixture fed to the foraminous burner is preferably a fuel gas and air mixture. In general, the mixture should preferably have a 10 to 80% stoichiometric excess of air over the fuel gas.

For a better understanding of the invention, reference will now be made, by way of exemplification only, to the accompanying drawing which shows schematically a furnace with gas inlets for use in the process of the invention.

The drawing shows a furnace of the same general type as described in European Specification No. 694 735, and Figure 3 thereof in particular. The furnace comprises a substantially cylindrical steel shell 1 having a top plate 2 from which depends a cylindrical screen 3 made from a supported adherent porous layer of ceramic matrix and/or metal fibres to form a foraminous burner 4 again of the same general type as described in European Specification No. 694 735.

A plenum volume 5 is therefore formed between the shell 1 and the screen 3 (and closed by the top plate 2 and a lower annular plate 6) in to which a fuel gas/air mixture can be fed via one or more inlet nozzles 7 to feed the combustion zone of the foraminous burner, a flame being formed in use on the internal surface of the screen.

The top plate 2 scalingly houses a plurality of pipes 8 for introduction in to the burner 4 of the exhaust gas stream admixed prior to its introduction with the fuel gas and oxygen.

Introduction of oxygen is effected from a source of oxygen (O_2) by means of oxygen lances 9 which are concentrically positioned within the pipes 8 and which have nozzles 10 which can introduce the oxygen gas in to the pipes 8; the nozzles 10 are situated at twice the diameter of the pipes 8 from the point of injection 11 of the exhaust gas stream in to the burner 4.

Introduction of methane as the fuel gas in to the gas stream in this example is effected upstream of the oxygen introduction in to the gas stream and is fed in to the pipes 8 from a source 12 via a pipe system 13.

To exemplify the use of a process of the invention in conjunction with the type of furnace shown in the drawing, a fuel gas/air mixture was supplied to the plenum volume 5 and, after diffusing through the screen 3, was ignited on the inner surface of the screen 3, ie within the foraminous burner 4.

An exhaust gas stream to be scrubbed was mixed with fuel gas upstream of the burner and with oxygen prior to its introduction to the burner 4 in the manner described above with reference to the drawing.

The Table shows the results of various tests to scrub a perfluorocarbon (PFC) gas from a gas stream comprising the perfluorocarbon in a nitrogen carrier gas, the perfluorocarbon being one of tetrafluoromethane (CF_4), sulphur hexafluoride (SF_6), nitrogen trifluoride (NF_3) and hexafluoroethane (C_2F_6), with varying amounts of methane (CH_4) as fuel gas and oxygen added to the gas stream in accordance with the invention.

TABLE

Test No.	PFC Gas	CH_4 Flow (slpm)*	N_2 Flow (slpm)*	PFC Flow (slpm)*	O_2 Flow (slpm)*	% Destruction
1	CF_4	0	50	1	0	0
2	CF_4	9	50	1	0	0
3	CF_4	0	50	1	14	0
4	CF_4	9	50	1	14	95
5	SF_6	0	50	1	0	0
6	SF_6	9	50	1	0	45
7	SF_6	9	50	1	14	100
8	NF_3	0	50	1	0	69
9	NF_3	6	50	1	10	100
10	C_2F_6	0	50	1.6	0	0
11	C_2F_6	9	50	1.6	0	54

TABLE (continued)

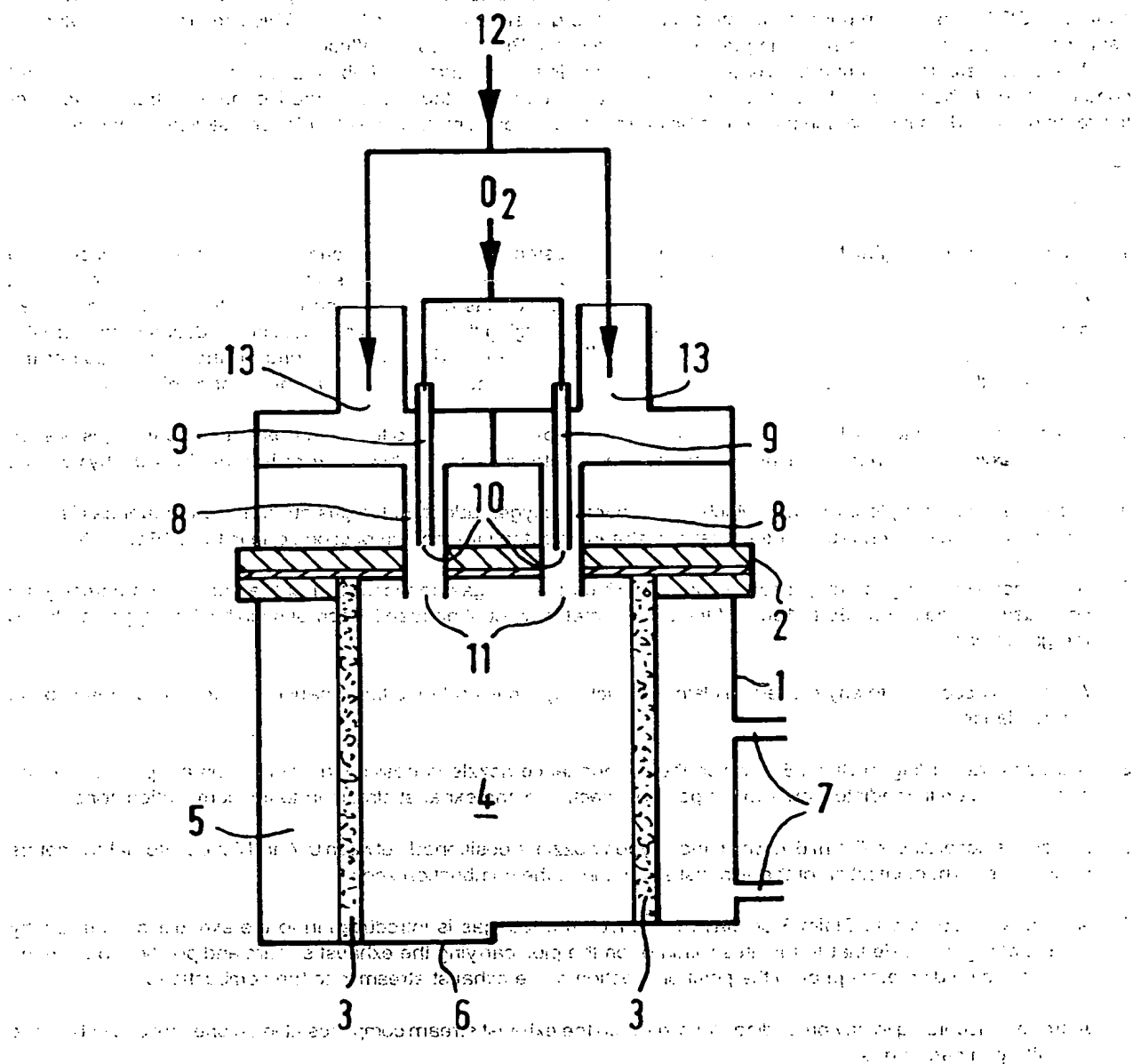
Test No.	PFC Gas	CH ₄ Flow (slpm)*	N ₂ Flow (slpm)*	PFC Flow (slpm)*	O ₂ Flow (slpm)*	% Destruction
12	C ₂ F ₆	9	50	1.6	14	100

The results shown in the Table confirm that with each of tetrafluoromethane (CF₄), sulphur hexafluoride (SF₆), nitrogen trifluoride (NF₃) and hexafluoroethane (C₂F₆), a level of destruction of these noxious substances from a nitrogen gas stream of at least 95% was achieved only with a combined presence in the gas stream of both a fuel gas, methane (CH₄), and oxygen prior to the introduction of the gas stream in to the burner. This confirms in particular the usefulness of the invention in scrubbing the most stable of the PFC gases, tetrafluoromethane.

The successful tests all had an oxygen concentration in the gas stream of about 20% and a fuel gas (methane) concentration of about 130% of the stoichiometric amount required for the oxygen added to the gas stream (the latter figure being based on two oxygen molecules being required for each methane molecule for a stoichiometric burn).

Claims

1. A process for the combustive destruction of noxious substances from a gas stream, which comprises injecting the gas stream and added fuel gas as a mixture in to a combustion zone that is surrounded by an exit surface of a foraminous gas burner and simultaneously supplying a fuel gas and air/oxygen mixture to the foraminous gas burner to effect combustion at the exit surface; and discharging the resulting combustion product stream from the combustion zone, wherein oxygen is added to the gas stream and the fuel gas prior to the introduction of the mixture to the combustion zone and wherein the oxygen/fuel gas mixture burns at the point of injection.
2. A process according to Claim 1 in which the amount of oxygen added to the gas stream and the fuel gas is such that the oxygen concentration of the total gas stream injected into the combustion zone is from 10 to 40% by volume.
3. A process according to Claim 2 in which the amount of oxygen added to the gas stream and the fuel gas is such that the oxygen concentration of the total gas stream injected into the combustion zone is from 15 to 25%.
4. A process according to any preceding claim in which the fuel gas concentration of the gas stream entering the combustion zone is from 80 to 150% of the stoichiometric amount needed for combustion by the oxygen added to the gas stream.
5. A process according to any preceding claim in which oxygen is added to the exhaust gas stream by means of an oxygen lance.
6. A process according to Claim 5 in which the oxygen lance nozzle is positioned within or on a pipe carrying the exhaust stream immediately prior to the point of injection of the exhaust stream in to the combustion zone.
7. A process according to Claim 6 in which the oxygen nozzle is positioned between 0.7 and 3 pipe internal diameters prior to the point of injection of the exhaust stream in to the combustion zone.
8. A process according to Claim 6 or Claim 7 in which the fuel gas is introduced in to the exhaust gas stream by means of a gas nozzle that terminates within or on the pipe carrying the exhaust stream and positioned between 0.7 and 3 pipe diameters prior to the point of injection of the exhaust stream in to the combustion zone.
9. A process according to any preceding claim in which the exhaust stream comprises at least one noxious substance in a nitrogen carrier gas.
10. A process according to any preceding claim in which the fuel gas of the mixture is a hydrocarbon.
11. A process according to Claim 9 in which the fuel gas is one of methane, propane or butane.



1. The present invention relates to a method of determining the position of a point in a three-dimensional space. The method is based on the principle of triangulation, which is a well-known technique in surveying and navigation. The method involves measuring the distances from a point to a set of known points, and then using these measurements to determine the position of the point.

2. The method of the present invention is particularly useful in the field of navigation, where it can be used to determine the position of a vessel or aircraft. The method is also useful in the field of surveying, where it can be used to determine the position of a point on the ground.

3. The method of the present invention is based on the principle of triangulation, which is a well-known technique in surveying and navigation. The method involves measuring the distances from a point to a set of known points, and then using these measurements to determine the position of the point.

4. The method of the present invention is particularly useful in the field of navigation, where it can be used to determine the position of a vessel or aircraft. The method is also useful in the field of surveying, where it can be used to determine the position of a point on the ground.

5. The method of the present invention is based on the principle of triangulation, which is a well-known technique in surveying and navigation. The method involves measuring the distances from a point to a set of known points, and then using these measurements to determine the position of the point.

6. The method of the present invention is particularly useful in the field of navigation, where it can be used to determine the position of a vessel or aircraft. The method is also useful in the field of surveying, where it can be used to determine the position of a point on the ground.

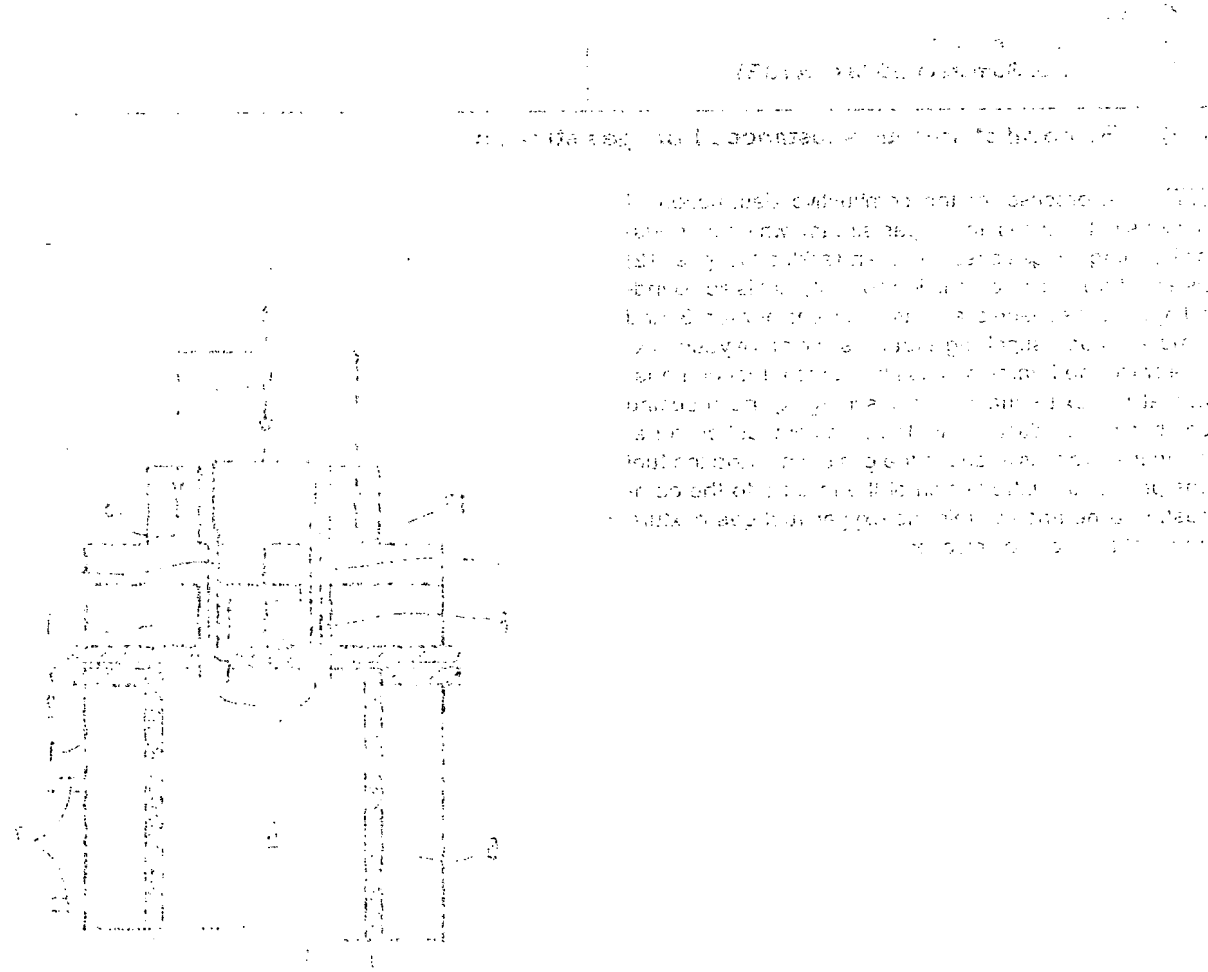
7. The method of the present invention is based on the principle of triangulation, which is a well-known technique in surveying and navigation. The method involves measuring the distances from a point to a set of known points, and then using these measurements to determine the position of the point.

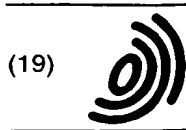
8. The method of the present invention is particularly useful in the field of navigation, where it can be used to determine the position of a vessel or aircraft. The method is also useful in the field of surveying, where it can be used to determine the position of a point on the ground.

9. The method of the present invention is based on the principle of triangulation, which is a well-known technique in surveying and navigation. The method involves measuring the distances from a point to a set of known points, and then using these measurements to determine the position of the point.

10. The method of the present invention is particularly useful in the field of navigation, where it can be used to determine the position of a vessel or aircraft. The method is also useful in the field of surveying, where it can be used to determine the position of a point on the ground.

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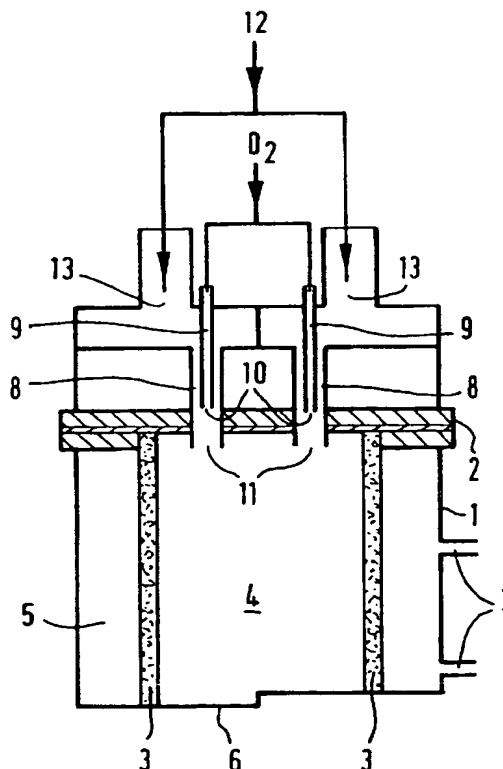
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(54) Removal of noxious substances from gas streams

(57) A process for the combustive destruction of noxious substances from a gas stream, which comprises injecting the gas stream (13) and added fuel gas (12) as a mixture into a combustion zone (4) that is surrounded by an exit surface of a foraminous gas burner (3) and simultaneously supplying a fuel gas and air/oxygen mixture (7) to the foraminous gas burner to effect combustion at the exit surface, and discharging the resulting combustion product stream from the combustion zone, wherein oxygen is added to the gas stream and the fuel gas prior to the introduction of the mixture to the combustion zone and wherein the oxygen/fuel gas mixture burns at the point of injection.





European Patent
Office

EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y,D	EP 0 694 735 A (ALZETA CORPORATION) * column 2, line 32 - column 3, line 19 * * column 5, line 42 - column 6, line 45 * * column 7, line 16 - column 7, line 41 * * figures 2,3 *	1,9-11	F23G7/06 F23D14/16
Y	WO 86 02023 A (L'AIR LIQUIDE) * page 2, line 14 - page 2, line 35; figure 1 *	1,9-11	
A	EP 0 212 410 A (HOECHST AG) * column 1, line 46 - column 2, line 21; figure 1 *	1	
A	US 5 123 364 A (GITMAN) * column 8, line 32 - column 8, line 61; figure 2 *	5,6	
A	EP 0 311 317 A (TOYO SANSO) * page 2, line 13 - page 2, line 20 * * page 3, line 55 - page 4, line 3 * * figure 1 *	9	
A	EP 0 655 582 A (THE BOC GROUP) -----		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17 October 1997	Examiner Phoa, Y
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document</p> <p>T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons</p> <p>&: member of the same patent family, corresponding document</p>			

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